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REVIEWS.

Geological Biology, an Introduction to the Geological History of Organisms. By H. S. WILLIAMS. Henry Holt & Co., 1895.

OF late years numerous books on evolution have appeared, but perhaps none have been more practical or suggestive in their treatment of the subject than the present volume by Professor Williams. The subject matter of the book was originally presented in the form of lectures, delivered first at Cornell University and later at Yale. These lectures were intended to supplement a laboratory course in palæontology, by suggesting the most vital lines of thought in the actual interpretation of fossils considered as the records of the history of organisms. In the preparation of the matter for publication the lecture form has been dropped and the material so revised as to serve the general reader as well as the student.

It is evident that the biologist proper, who deals alone with contemporaneous organisms, must rest with a theoretical interpretation of the laws of evolution. The actual records of the history of organisms are found in the fossils preserved in the rocks and it is the purpose of the author to point out the chief facts and factors of evolution as shown from a study of the fossils.

In beginning the study of any history some system of chronology must be adopted. In the early chapters of the book the author discusses the development of the geological time-scale as now generally adopted, passing from the earliest classification of rocks based on their original order of formation, through the second stage in which the classification was based on their mineral constituents, to the present classification based on their fossil contents.

Fossils represent the hard parts of living organisms, or those parts which have attained definite and fixed form during the life of the organism. "The history of organisms, which we particularly trace in the study of fossils, is not the history of imperfect organisms struggling towards perfection, but it is the history, for each age and epoch, of the perfected adjustment of the organisms of the time to the particular conditions of environment in which they lived. They did not die before their time, overcome by the mythical fittest who are said to survive in the struggle. They were the fittest, and died natural deaths, having provided before they gave up the struggle for their progeny to succeed them. The hard parts record the history of adults which have endured the struggle, and thus represent the royal line of succession for the geological ages."

Evolution is a fundamental law in the geological history of organisms. The "morphological differentiation (*evolution*) is as characteristic of the history of organisms in geological time as organic growth (*development*) is characteristic of the history of the individual organism in its lifetime." With the progress of time the morphological characters assumed by organisms have been gradually and incessantly changing from the beginning. This constant change or evolution is a fundamental law of organisms. Inorganic things on the contrary are unchangeable. The chemical composition and properties of things are the same as far back as we can trace them. A quartz crystal formed in Archæan time has exactly the same form with exactly the same angles as a crystal of the same substance formed today.

A certain analogy between ontogenesis and phylogenesis is commonly recognized. As each individual has a life history, so also has each species, genus, family, etc., but this fact must be emphasized, that in the individual development a *change of function* is associated with the several stages of ontogenesis; while it is difficult to imagine any corresponding change of function in the successive representatives of a common race. For this reason great caution is necessary not to force the theory of correspondence between the ontogenetic stages of functional activity and the order of differentiation of new characters expressed in the phylogenetic history of organisms. The two series of phenomena present this marked contrast, that in ontogenesis each phase of development is a repetition of phenomena which have been repeated in the same way from the beginning of organic life, while in phylogenesis each step is a step in advance of anything that has occurred before.

Evolution and adaption are both observed facts. The continuous morphological change of organisms, coördinate with the progress of time, is evolution. In this onward progress of organisms they are everywhere locally adapted to the particular environment in which they are placed. This adaptation to environment is brought about through the action of natural selection, but this adaptation is not the evolution nor is natural selection the cause of evolution, but only one of the factors in the process of evolution. A first cause of some sort is essential to any complete theory of evolution.

"Among those today who adopt evolution as the explanation of the mode of origin of the different forms of organisms, there are two extremes of opinion with many intermediate compromises.

"All will agree in recognizing ancestry and environment as each taking some part in the evolution; but the extreme school, on the one hand, holds that *environment* is the chief factor determining the direction and extent of the modifications, which heredity tends to perpetuate, and that ancestry plays only the part of holding and preserving, in its offspring, what it gets from the agency of environment.

"The other extreme is the opinion that *ancestry* is the more efficient factor in bringing about the evolution; that in what is called *variability* there is working out, not a mere accidental reflex of environment upon the plastic organism, but a fundamental property or force of organisms, ever tending from homogeneity to heterogeneity and resulting in the specialization of functions and the differentiation of organic structure always; the line of evolution followed out by any particular race being influenced little by environment,—the adjustments being active and not passive, — the successful organisms seeking and adopting conditions favorable for their existence if out of them, dying out if the conditions favorable are not within reach, or if crowded out of them. Natural selection to this school of opinion plays rather an eliminating rôle than one of causation, and explains rather why there are gaps in the series of organisms than why the characters assumed in the modified forms are what they are. In this latter view the successive steps of modification of a race are as much controlled by the ancestry as are the successive steps of development in the growth of the individual.

"In the former view there is the replacement of the theory of immutability of species by that of the mutability of species, but the process of reproduction is still looked upon as immutable, reproducing the characters of the parents in the offspring without change; in the second view reproduction itself takes a part in evolution and normally accomplishes modification of form, either slowly or suddenly, but progressively, and evolution is an intrinsic law of organism."

Mutability of species is the central thought in the new theory of the origin of species. Darwin first clearly announced that *species are* *mutable*, and as the whole science of natural history was constructed on the idea of their immutability, a complete readjustment of the science has resulted. With the revolution of thought started by Darwin's "Origin of Species," came a new conception of the nature of species. "The change was a philosophical one; no longer was the species considered to be a permanent entity with definite boundaries, but in the definition of organic species its time-relations and its geographical distribution were elements added to those of its morphology and physiology. This was a great advance. The organism came to be recognized not as a mere concrete being independent and standing by itself, constituted at the beginning what it is and remaining so during its existence, but as a very dependent part of a greater organism, nature itself, and related intimately with its surroundings or environment, to the organisms which preceded it or its ancestry, and to those which are to follow it or its descendants, as a sensitive, slowly changing reflex of all that has been and is. In the new conception there is the dim outlining of the idea (an old idea, but one which is day by day growing more distinct and of fuller comprehension) that nature itself is a greater organism in which the species is but one of the organs."

The problem of the origin of species came to be a question for scientific investigation, only when the old idea that variations were not cumulative, but were always simply variations, was superseded by the newer idea that variations are cumulative, and that reproduction is not a process of exact but of inexact repetition of characters. Variability is thus assumed to be an inherent characteristic of all organisms. The natural inference from the Darwinian explanation of the origin of species is that characters appearing first as varieties are through continuous repetition in the process of generation, gradually elevated to specific, generic, family, etc., rank. Palæontologists are inclined to doubt the fact of natural selection playing such an all-important part in the evolution of organisms. Cope has expressed the idea that evolution of generic characters has progressed in a different way, and has developed the idea of the law of acceleration and retardation which acts in association with natural selection but independent of it. There is assumed to be a special developmental growth force which is exhibited in variation itself and which becomes effective, as phylogenetic evolution, through acceleration and retardation. The Darwinian or natural selection school of evolutionists is engaged in accounting for the acquirement of permanence of originally variable elements, while the Neo-Lamarkian school is engaged in accounting for the variability itself.

The laws of evolution as illustrated by the life-history of the brachiopoda are fully discussed by the author. The evidence obtained from this class of organisms points to the fact that the evolution of those characters which mark the differences between separate classes, orders, suborders and even families of organisms, has taken place in a relatively short period of time; taking as a measure either the rate of general progress in the differentiation of organisms, or the length of the life period of each particular genus or family. This rapid evolution is difficult to account for by any working of natural selection. Two factors are at work in the process of evolution which are designated as intrinsic and extrinsic evolution. "*Intrinsic evolution* is conceived of as normal expansion and differentiation of the organism itself from within, and is the expression, in some way, of an intrinsic tendency of the particular race of organisms. The other, *extrinsic evolution*, expresses the limitation and selection exerted upon the organism from without."

Illustrations of the laws of evolution are further drawn from other classes of organisms as the Cephalopoda and Vertebrata. From all these illustrations it is pointed out that the geological evidence does not emphasize the importance of natural selection as a factor in evolution. The following paragraphs may be quoted as setting forth the views of author.

"That which has seemed most conspicuous to the latter class of observers (students of living organisms) has been the intimate relationship existing between morphological difference and environmental conditions; palæontological facts point to the greater importance of the continuous and progressive process of differentiation and specialization of structure and function with the passage of geological time.

"The facts examined . . . . . show that evolution is rather an intrinsic law of organisms, and is to be discovered in the phenomena of variation, which appear to be constantly active, rather than in any accidental operations dependent upon the conditions of external environment.

"Evolution is seen to be a process that is primarily organic; it is expressed in the acquirement of new characters in the course of growth by living organisms; and we may as reasonably speak of evolution as of the growth force of the individual or the force of gravitation. As the normal laws of growth of the individual are thwarted and diverted by external conditions, so undoubtedly a greater or less modification of the course of evolution has been produced by the conditions of environment.

"When we attempt to explain the course of evolution by tracing it backward from the differentiated, adjusted organisms to its ancestors, it is natural to place great importance upon the fact of the accomplished adjustment of the individual to its particular environment; but when the point of views is reversed and the organism is traced from the earlier geological periods through the ages down to the present time, the conviction becomes impressed upon the student that environmental conditions are but the medium through which the organic evolution has been determinately ploughing its way." S. W.

Canadian Fossil Insects. By S. H. Scudder. Contributions to Canadian Palæontology, Vol. II., Part. 1 (1895).

This publication includes three different papers by Prof. Scudder.

1. *The Tertiary Hemiptera of British Columbia.* Descriptions are given of nineteen species from three different localities—Quesnel on the Fraser, the north fork of the Similkameen River and Nine Mile Creek flowing into Whipsaw Creek, a tributary of the Similkameen. Dr. Dawson considers the two latter localities to be portions of a single ancient lake, so only two basins are concerned. The two basins afford specimens of very different character and may prove to represent different stages in the Tertiary. The age of the beds is probably as old as the Oligocene.

The great diversity of this ancient insect fauna may be judged from the fact that in nearly every case each specimen must be referred to a distinct species, and in only one case can two species be referred to the same genus. The most striking feature of the fauna is the large size of the individuals which compose it.

2. *The Coleoptera hitherto found fossil in Canada.* Fossil Coleoptera have been found in seven distinct localities at three very different horizons, viz., Post-Pliocene, thirty-two species, lower Tertiary, fourteen species, and Cretaceous, one species.

The most interesting fauna is that from the inter-glacial deposits of